Example name: ÉcoTerra

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For installations

BISTS Location: Eastman, Quebec
72º 18' W
45º 18' N

Climate Type: Dfb

Building Use: Residential building

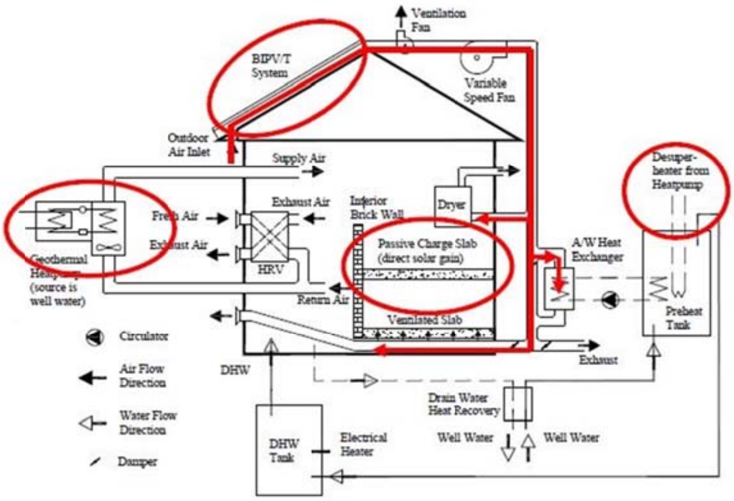
Level of BISTS integration
Rush: Level 2
Reijenga: 3

X New Build
O Refurbishment
O Other: ……………………

Type of BISTS:

Hybrid

Function(s):
X Air heating
X Water heating
O Combi-system
X Cooling/ventilation/shading
X PV/T
X linked to another system (e.g., heat pump)
O Other: ………………………



Building element:

X Facade
X Roof
O Other: ……………………..

BISTS characteristics:

BIPV/Thermal System: A 2,84kW BIPV/T system was applied. It have 22 Unisolar amorphous silicon 136W laminates placed on the 55 m^2 south-facing metal rooftop. The PV potential annual electricity production was estimated at approximately 3420kWh for a slope of 30,3º. This system is an on-grid application accompanied with an inverter for AC/DC conversion, allowing the redirection of the locally generated electricity surplus to the grid. The heat is recovery from the PV with the ventilator; this system has the capacity to produce up to 12 kW of heat at a 14 m^3/min of air flow. The hot air extracted is used for drying clothes or to preheat water through an air-to-water heat exchanger installed in the house. It is estimated that the PV heat recovery system will provide 700kWh of the annual 900kWh clothes dryer energy load. The BIPV/T system is therefore expected to reduce the space heating load by approximately 3800kWh in the heating season and for the other 7 months is estimated to supply approximately 1400kWh of the annual DHW heating requirements.

Geothermal Heat Pump: A two-stage geothermal heat pump is used to heat or cool the building, also the heat pump is used assists the hot water production, permitting to reduce the energy consumption by approximately 700kWh/yr.

Passive Solar Design: Large south-facing windows, triple glazed windows in all building façades, passive charge concrete slab and brick wall and motorized blinds.

The annual space energy consumption could be as low as 1130kWh. The electricity used to produce DHW could be reduced from 3353kWh to 553kWh. The energy used for lighting and appliances can decreased from 3974kWh to 3274kWh. Subtracting the PV electricity generation of 3420kWh, it is possible to obtain an annual energy consumption of 2155kWh.

ÉcoTerra is a prefabricated home; it was delivered in five modules.

Stage of Development: Complete **Responsible:** Concordia University/Alouette Homes

O	Idea/Patent	…………………………………..
O	Prototype	…………………………………..
X	Demonstration	ÉcoTerra
O	Integral building element	…………………………………..
O	Commercially available	…………………………………..

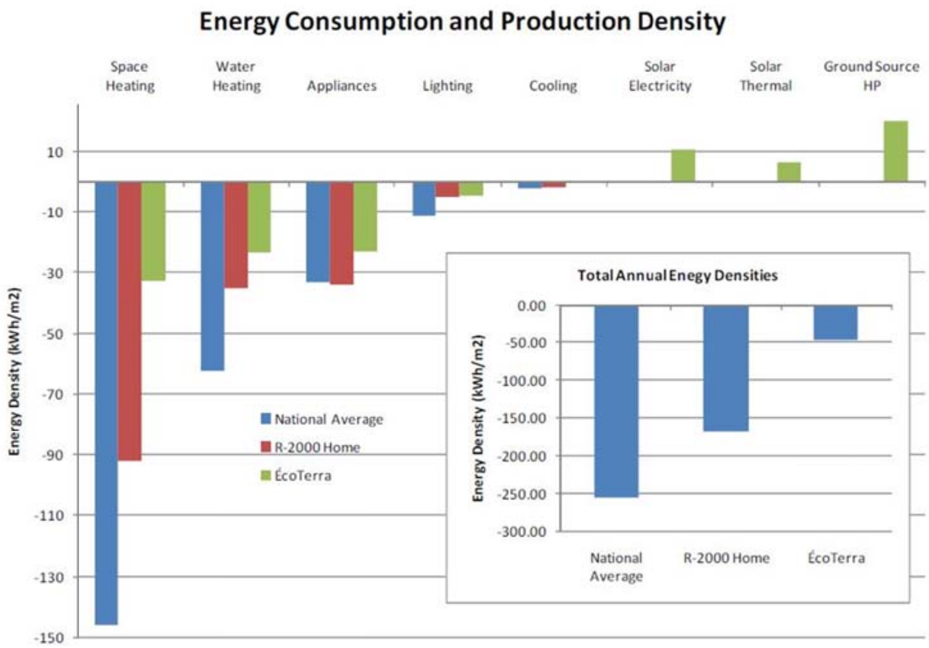
BISTS description and context

Project motivation: Represents the first net zero-energy home in Canada, attempt to combine energy-efficient construction techniques and renewable energy systems to achieve Canada’s energy efficient guide and be affordable for Canada income.

ÉcoTerra is a two-story detached home on a 1,1hectare rural lot. A closed garage is located on the north side of the house and is attached to the façade to act as a buffer space and reduce the fabric heat loss. It has a heated volume of 671,4 m^3 and a heated floor area of 230 m^2. The ceiling area is 87,06 m^2 and the exposed wall area 219,73 m^2.

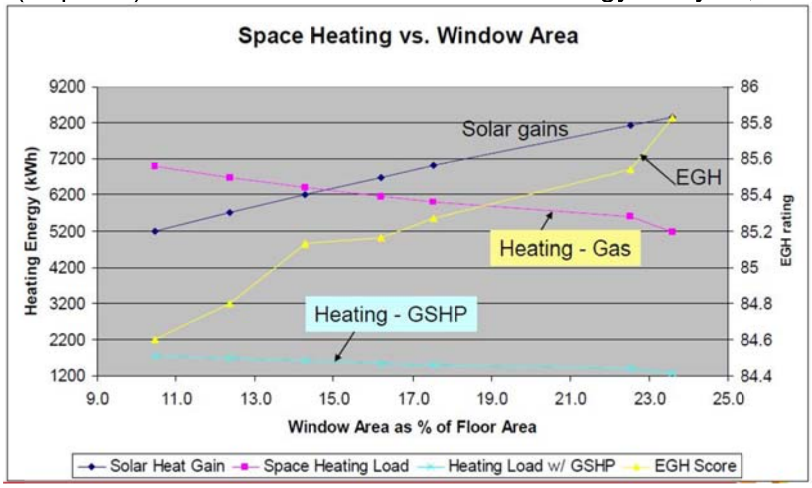
In 2006 the project was submitted in CMHC Equilibrium housing competition, in 2007 there was the on-site construction of modules, from August 2008 to July 2009 it was made the official monitoring of the unoccupied house. In the August 2009 the house was occupied.

System viability



Modelling and simulation tools developed/used

- HOT2000 (required): used for whole house annual energy analysis;



- RETScreen (required): used for design of renewables (PV, in this case);
- MathCAD: design day analysis of passive solar performance and design of BIPV/T and ventilated slab.

BISTS Performance data

Based on:
X Estimation
X Detailed simulation
HOT2000; NRCan’s RETScreen; MathCAD
X Measurement/testing
X Long-term monitoring

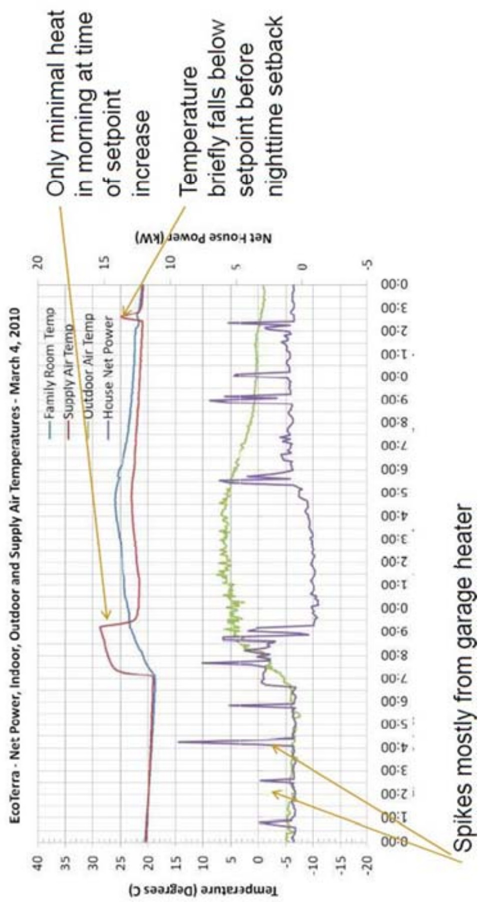
Performance parameters

For integrated systems:
key performance indicators -

Solar savings fraction: %
Light transmittance: %
Solar transmittance: %
Total solar energy transmittance: %:
Solar heat gain factor:
Building fabric U-values: …W/m^2K
Noise, fire, etc ratings
Other:

For separate collectors:
performance rating coefficients -

Other:



Additional information: ***Upgrades to promote***

Upgrade #1: Smarter airflow controls:
Issue: fan is currently on (low-speed) all the time. Significant stratification only occurs in early afternoon. Mean ΔT = 0.45°C;
Solution: turn fan on only if temperature between thermal zones exceeds 2°C;
Result: Fan is on for 32.8% of year; mean ΔT = 1.40°C. Energy savings of 1690 kWh. Modest effect on comfort.

Upgrade #2: Smarter airflow controls:
Issue: air cleaner (in line with HRV) is arguably unneeded (house is far from pollution sources);
Solution: Remove it;
Result: 429 kWh savings.

Upgrade #3a: Garage heating:
Issue: Garage is used as workshop; electric resistance heating unexpected added. Predicted 2660 kWh heating load.);
Solution: Supply heat with GSHP (assumed setpoint 12°C during daytime only; as requested by owners);
Result: 1920 kWh savings (over electric resistance heater).

Upgrade #4: Increased PV efficiency and slope:
Issue: Slope is slightly below optimal and accumulates snow;
Solution: Increase slope to 40° and double nominal PV efficiency to 12.6%;
Result: Predicted additional 4320 kWh/year of generation.

Sources and references:

[1] Noguchi M, Athienitis A, Delisle V, Ayoub J, Berneche B. Net Zero Energy Homes of the Future: A case study of the ÉcoTerra™ house in Canada. Presented at the Renewable Energy Congress, Glasgow, Scotland, 19-25

INSTRUCTIONS

Please fill in as much information as possible.

Tick where appropriate.

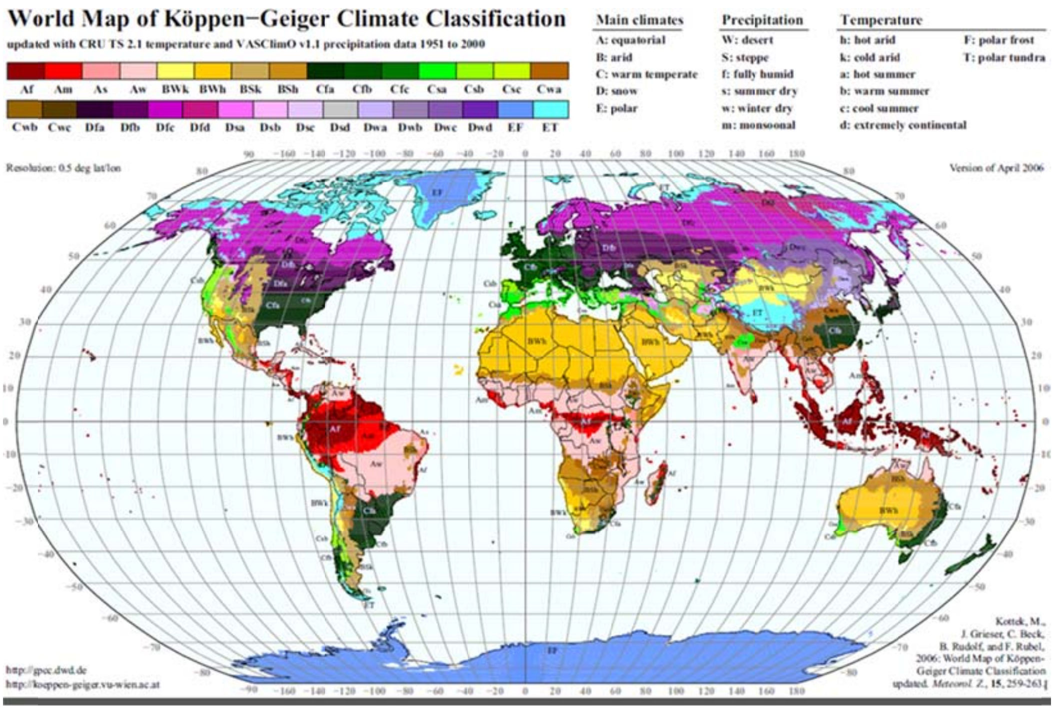
Text in red is suggested guidance. Insert information in provided space, removing red text as appropriate

If possible, use metric values.

If necessary, supply additional information on separate sheets

<u>Reference listing</u>

Köppen climate classification



(Kottek, M., J. Grieser, C. Beck, B. Rudolf, and F. Rubel, 2006: World Map of Köppen-Geiger Climate Classification updated. Meteorol. Z., 15, 259-263.)

Reijenga classification

The integration of PV systems in architecture can be divided into five categories:

1. Applied invisibly
2. Added to the design
3. Adding to the architectural image
4. Determining architectural image
5. Leading to new architectural concepts.

(Reijenga, TH and Kaan, HF. (2011) PV in Architecture, in Handbook of Photovoltaic Science and Engineering, Second Edition (eds A. Luque and S. Hegedus), John Wiley & Sons Ltd, Chichester, UK)

Rush classification

The architectural/visual expression of building services systems are identified as:

Level 1. Not visible, no change
Level 2. Visible, no change
Level 3. Visible, surface change
Level 4. Visible, with size or shape change
Level 5. Visible, with location or orientation change

(Rush, RD. (1986) The Building systems integration handbook Wiley, New York, USA)

Collector test standards

BS EN 12975-2 2006 'Thermal solar systems and components solar collectors - Part 2 test methods'
ASHRAE Standard 93-2010 'Methods of Testing to Determine the Thermal Performance of Solar Collectors'
ASHRAE Standard 95-1987 'Methods of Testing to Determine the Thermal Performance of Solar Domestic Water Heating Systems'